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The National Food Supply in Peace and War

T. B. WOOD, M.A.

Fellow of Gonville and Caius College; Drapers' Professor of Agriculture in the University of Cambridge; Member of the Food (War) Committee of the Royal Society

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UNIVERSITY OF CALIFORNIA

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PREFACE

IN the present crisis the question of the supply of food for the population of the country, both human and animal, has come to occupy a place in the mind of the intelligent sections of the community which is unprecedented since the Napoleonic era. In the long period of comparative peace which preceded the present conflagration, the fact that the United Kingdom had to rely for two-thirds of its work-producing power on food from overseas did not disturb the minds of the general public. Nowadays, however, it has become a matter of absorbing interest to every thinking man, and almost a nightmare to many.

So far as I am aware, the actual facts of the situation as they concern both man and beast are not generally available. I have therefore attempted, in the following pages, to present them in a readily intelligible form. My object in doing so is to enable the general public to form a fair estimate of the situation. I am convinced that an admittedly difficult situation will be faced more cheerfully and more resolutely by the population of the country in proportion as it is generally understood.

T. B. W.

CAMBRIDGE
July 1917

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I

THE NATIONAL FOOD SUPPLY BEFORE THE WAR

Sources of Information.

This subject has been studied most carefully and thoroughly by the Food (War) Committee of the Royal Society. The results of their investigation, which was undertaken at the request of the President of the Board of Trade, have been published as a Command Paper, (Cd.) 8421, which can be ordered from any stationer for *4d.* Broadly speaking the method followed by the Committee in making their estimate of the National Food Supply was as follows:

The food of the nation is either home-grown or imported. Estimates of the produce of home-grown crops are published annually in the Returns of the Board of Agriculture and Fisheries. These estimates give the total produce of wheat, oats, etc. From these figures it is necessary to make certain deductions for the estimated amounts used for seed, for feeding animals, and for various industrial purposes. In this way, it is possible to arrive at the amount left for human consumption.

For foods, such as milk and butter, not included in the returns of the Board of Agriculture, figures were obtained from the Census of Production, which after certain corrections and adjustments gave the desired information.

Information as to the amounts of food stuffs imported was obtained from the Annual Statement of Trade, compiled by the Statistical Office of the Customs and Excise Department and issued by the Board of Trade. Deductions were made for re-exports, and for the amounts estimated to be consumed by animals and to be used in various industries. The remainder was assumed to be available for human consumption.

Further details are not necessary. It is sufficient to note that every possible point was thoroughly investigated, and the estimate here given, abridged from (Cd.) 8421, page 7, is undoubtedly as near the truth as such an estimate can be expected to be. This estimate is given in detail in Table I and is summarised in Table II.

Before discussing the figures and facts set out in Tables I and II, a word is necessary about the figures themselves. The weights are given in metric tons of 2,205 lbs. This unit was selected because not only is it very nearly equal to a British ton of 2,240 lbs., but, being equivalent to 1,000 kilogrammes, it forms a convenient connection with the metric system of weights and measures used on the Continent. It will be noticed that the columns of weights are not totalled. This omission is deliberate, because it would obviously be misleading to add together dry foods such as wheat flour, moist succulent foods such as vegetables, and liquid foods such as milk. Before such foods can be totalled, it is necessary to convert them to a common basis. For this purpose it is necessary to select some unit of measurement which is common to all foods. Observations have shown that the human being derives his power of doing work from the oxidation of his food, which in this respect is comparable to the fuel of a steam engine or motor-car. The work-producing power of coal, oil, or petrol is measured in calories or units of heat. This unit is the most convenient measure for the work-producing power of foods. This does not mean that anything which yields calories on burning is valuable for human food. An ordinary motor-car will not run on common paraffin. In the same way the human body is particular as to the source of its calories. In other words, it can only utilize certain well-known foodstuffs. The work-producing power of a man depends on the number of calories supplied by his food as strictly as the work-producing power of a steam engine depends on the number of calories in the coal with which the furnace is stoked.

For the present purpose it is not necessary to consider the protein supplied by different foods, because a man who eats enough food to provide the calories necessary for the work he has to do, must exercise considerable ingenuity if he is to avoid

eating enough protein. To include figures for protein would therefore complicate the tables without really advancing the argument.

Food consumed by the "Average Man."

The Tables show that in the five years before the war the nation was consuming the enormous number of 51 million million calories in its food. For an estimated average population of 45·2 millions this works out at 3,091 calories per head per day.

Now, the food requirements of different individuals vary according to age, sex, and occupation, and this variation must be taken into account before it is possible to compare the above figure of 3,091 calories per head per day with existing standards. To do this, the procedure is as follows:

It is agreed to call the requirements of an average man doing an average day's work 1. Then an average woman doing an average day's work requires ·8, a child of five years or less requires ·4, and so on.

The figures of the 1911 census were consulted to find out the distribution of the population between the various ages, and with this information the following calculation was made.

Ages		Numbers	Relative food requirements	Equivalent to average men
0– 5		5,772,153	0·4	2,308,861
6– 9		3,708,513	0·5	1,854,256
10–13		3,548,403	0·6	2,129,042
14–15	Males	862,203	0·8	689,762
	Females	859,815	0·7	601,870
16 and above	Males	14,574,430	1·0	14,574,430
	Females	15,948,114	0·8	12,758,491
Total		45,273,631		34,916,712

The total population of 45,273,631 individuals thus requires the same amount of food as would be required by 34,916,712 average men each doing an average day's work. From this it follows that a fair sample of 100 individuals would require

Table I. Food Supply of the United Kingdom.

Average of 5 years, 1909 to 1913 inclusive.

	Weight in metric tons			Work-producing power in millions of calories		
	Home grown	Imported	Total	Home grown	Imported	Total
Cereals:						
Wheat, flour, shredded wheat, etc.	840,000	3,485,000	4,325,000	3,051,000	12,687,000	15,738,000
Oatmeal, rolled oats, etc.	145,000	55,000	200,000	559,000	205,000	764,000
Barley products	25,000	25,000	50,000	95,000	96,000	191,000
Tapioca, sago, arrowroot, etc. ...	—	100,000	100,000	—	353,000	353,000
Maize products	—	50,000	50,000	—	170,000	170,000
Rice	—	140,000	140,000	—	496,000	496,000
Meat:						
Beef and veal...	820,000	491,000	1,311,000	2,378,000	1,122,000	3,500,000
Mutton	294,800	182,200	477,000	986,000	508,000	1,494,000
Lamb	36,200	83,800	120,000	86,000	198,000	284,000
Bacon	80,000	228,000	308,000	479,000	1,364,000	1,843,000
Hams	20,000	44,000	64,000	77,000	164,000	241,000
Pork and other pig flesh	304,000	41,000	345,000	1,258,000	165,000	1,423,000
Meat offals	60,000	—	60,000	105,000	—	105,000
Poultry, Eggs, etc.:						
Poultry	41,000	14,000	55,000	62,000	18,000	80,000
Eggs	129,000	129,000	258,000	173,000	173,000	346,000
Rabbits, imported	—	18,000	18,000	—	35,000	35,000
Fish:						
Herrings	99,000	63,000	162,000	82,000	57,000	139,000
Other fish, fresh	606,000	30,000	636,000	306,000	12,000	318,000
Shell fish (without shell)	10,500	1,900	12,400	4,000	—	4,000
Canned and salted fish	—	38,000	38,000	—	70,000	70,000

Produce:						
Milk (including cream)	4,500,000	—	4,500,000	3,224,000	—	3,224,000
Butter...	114,000	207,000	321,000	906,000	1,645,000	2,551,000
Cheese...	30,000	117,000	147,000	116,000	457,000	573,000
Condensed milk	—	2,200	2,200	—	—	—
,, ,, sweetened	—	53,000	53,000	—	176,000	176,000
Margarine	60,000	58,600	118,600	469,000	460,000	929,000
Lard	—	90,000	90,000	—	800,000	800,000
Fruit:						
Apples	127,000	163,000	290,000	57,000	74,000	131,000
Bananas	—	150,000	150,000	—	99,000	99,000
Nuts	—	38,000	38,000	—	100,000	100,000
Fruits, fresh	214,000	430,000	644,000	111,000	231,000	342,000
,, preserved with sugar ...	—	149,000	149,000	—	405,000	405,000
Vegetables:						
Potatoes	3,988,000	262,000	4,250,000	3,756,000	246,000	4,002,000
Beans, peas and lentils	—	116,000	116,000	—	421,000	421,000
Green peas and broad beans (shelled)	100,000	—	100,000	107,000	—	107,000
Other vegetables (including tomatoes)	700,000	295,000	995,000	191,000	83,000	274,000
Preserved vegetables	—	21,000	21,000	—	8,000	8,000
Sugar, Cocoa, etc.:						
Cocoa (and chocolate)	—	36,000	36,000	—	225,000	225,000
Sugar taken as refined	—	1,525,000	1,525,000	—	6,130,000	6,130,000
Molasses	—	33,000	33,000	—	74,000	74,000
Glucose, solid...	—	18,000	18,000	—	61,000	61,000
,, liquid	—	45,000	45,000	—	143,000	143,000
Cottage produce*	—	—	—	2,227,000	—	2,227,000
Farm produce* (consumed by producers)	—	—	—	428,000	—	428,000
Totals	—	—	—	21,293,000	29,731,000	51,024,000

* These items represent the produce of private gardens and that portion of the produce of farms which is consumed by the producers and does not reach any market.

Table II.

Summary of Food Supply of United Kingdom.

Average of 5 years, 1909 to 1913 inclusive.

	Weight in metric tons			Work-producing power in millions of calories		
	Home grown	Imported	Total	Home grown	Imported	Total
Cereals	1,010,000	3,855,000	4,865,000	3,705,000	14,007,000	17,712,000
Meat	1,615,000	1,070,000	2,685,000	5,369,000	3,521,000	8,890,000
Poultry and eggs, game and rabbits ...	170,000	161,000	331,000	235,000	226,000	461,000
Fish	715,500	132,900	848,400	392,000	139,000	531,000
Dairy produce (including lard and margarine)	4,704,000	527,800	5,231,800	4,715,000	3,538,000	8,253,000
Fruit	341,000	930,000	1,271,000	168,000	909,000	1,077,000
Potatoes and other vegetables ...	4,788,000	694,000	5,482,000	4,054,000	758,000	4,812,000
Sugar including cocoa and chocolate ...	—	1,657,000	1,657,000	—	6,633,000	6,633,000
Cottage and farm produce not included above	—	—	—	2,655,000	—	2,655,000
Totals	—	—	—	21,293,000	29,731,000	51,024,000

as much food as 77 men, and food requirements per head can therefore be converted into food requirements per average man by multiplying by 100 and dividing by 77. The food consumed per average man per day, therefore, works out at 3,091 × 100 ÷ 77 calories, or 4,009 calories.

The generally accepted standard of diet for an average man doing an average day's work is 3,400 calories, so that the food supply before the war allowed a margin of 600 calories per man per day or 15 per cent.

The analyses used in computing the number of calories supplied by the various foods were analyses giving the proportion which with reasonable care can be made actually available, allowance being made for the proportion of calories lost in preparing the food for table. The margin indicated is therefore a real excess above the estimated physiological requirements of the population. It means that in the five years before the war, the waste of food was 15 per cent. greater than it need have been. This excess is accounted for partly by loss in distribution, partly by waste in the household, and possibly, to a small extent, by actual over-eating by some persons.

As regards waste in the household, by far the largest item of loss is the waste of fat from our fat meat. The waste of bread and other cereal products is extremely small.

Whatever factors conduced to the excess, part of the margin has probably disappeared under present conditions, for the increase in the proportion of the population now engaged in strenuous work has almost certainly raised the total physiological requirements of the nation to a greater extent than it has been possible to add to the supplies.

To return once more to Tables I and II, a mere glance at the figures suffices to show that different articles of food contribute widely different proportions to the National Food Budget. The figures in Table III, reduced from Table I, show this more clearly. In compiling this Table, the figure for potatoes given in Table I has been increased by an estimated allowance for the potatoes consumed by the growers. These are included in Table I under the head of Cottage and Farm Produce. Further, it is estimated that about one-seventh of

TABLE III. WORK-PRODUCING POWER OF DIFFERENT FOODS.

Percentage of total work-producing power contributed by various classes of foods, 1909–1913.

Bread	26	
Flour used in cooking	4	
Total from wheat		30
Oatmeal	1·6	
Barley products	0·4	
Sago, Tapioca, etc.	0·7	
Maize products	0·3	
Rice	1·0	
Total from cereals other than wheat		4
Total cereals		34
Meat (beef, mutton, pork, bacon, veal, lamb, poultry, game)		18
Dairy produce (milk, cream, butter, cheese, margarine)		15
Sugar in all forms		13
Potatoes		10
Other items (fish, fruit, vegetables)		10
Total		100

the total amount of flour consumed in the country is used for making cakes, puddings, pastry, etc., the remaining six-sevenths being made into bread.

Importance of Cereals.

These figures show the predominant position occupied by the cereals in the national dietary. During the five years before the war, they contributed over one-third of the total work-producing power of the nation. This statement, however, scarcely gives a just appreciation of their importance, since it ignores the fact that in the diet of those sections of the community who are engaged in manual work, cereals frequently yield nearly two-thirds of the work-producing power. In many districts, for instance, the agricultural labourer habitually eats a two pound loaf of bread every day. This alone provides nearly two-thirds of the calories such a man actually requires. Labourers do not eat these large quantities of bread because

they prefer it to any other kind of food. Their choice of food is not free. It is restricted by two factors, price and convenience. Before the war, bread cost 1⅝*d.* per lb. One pound of bread yields 1,200 calories of work-producing power. In the form of bread, therefore, a penny bought nearly 900 calories. Even at the present price of 3*d.* per lb., bread gives 400 calories for a penny. In no other food which can be bought in sufficient quantities does a penny buy so much work-producing power. Added to this, bread requires no cooking, is readily portable,—a great consideration to the worker who has to carry his dinner with him,—keeps well, and by long ingrained habit has become the staple article of the worker's diet.

The figure given for bread in Table III corresponds to only about 4½ lbs. of bread per head per week. This is far short of the consumption of the labourer mentioned above. It is, of course, an average of the high consumption of the labourer and the low consumption of those who are engaged in sedentary employment, those who eat little bread because they can afford to buy other more appetising foods, and those who habitually replace bread by potatoes or oatmeal, as happens in Ireland and Scotland.

The consumption of bread by different individuals varies from 14 lbs. per week in the case of the agricultural labourer to, say, 2 lbs. per week in the case of the unoccupied man of sedentary habits.

As regards cereals, therefore, we may conclude by pointing out that bread is the staple diet of the nation, and especially of those classes who are engaged in manual work, that all other cereal products taken together supply less than one-eighth as much work-producing power as do bread and flour, and finally, that of the total cereals consumed for human food only about one-fifth is home grown.

Meat.

After the cereals, the next most important item in the nation's food budget is meat which, if beef, mutton, pork, bacon, ham, veal, lamb, poultry, eggs and game are included, supplies 18 per cent. of the total national work-producing

power. As in the case of bread, the consumption of meat varies widely in different classes of the community. It forms a comparatively large proportion of the diet of those sections of the population whose purchasing power enables them to ignore price in choosing their food.

In the form of meat at pre-war prices, a penny would only buy about 150 calories. Manual workers' wages did not enable them to buy work-producing power at this rate, and meat consequently formed only a small proportion of their diet. The extremes of meat consumption were probably 1 lb. per head per day by the rich, and under 1 lb. per head per week by the poor. The average consumption for the whole population was about 2½ lbs. per head per week.

Bread v. Meat.

From studies of the diet of different classes with varying incomes, it appears that, as the income of a household per head falls, bread consumption rises and meat consumption falls, and *vice versa*, as the income per head rises, bread consumption falls and meat consumption rises. In other words, bread and meat are found to replace each other, the relative proportions in which they are eaten being controlled by the purchasing power of the housewife. Finally, it should be pointed out that rather less than two-thirds of the meat consumed in the United Kingdom was home grown.

Bread and meat together account for 52 per cent., or over half, the total work-producing power of the nation. Although they replace each other, no other single article of food can replace either of them to any appreciable extent, simply because no other article is available in sufficient quantity.

Dairy Produce.

Dairy produce, including milk, cream, butter, cheese and margarine, yields 15 per cent. of the work-producing power of the nation,—an important contribution not much smaller than that of meat. Fresh milk and cream were entirely home produced, though a considerable quantity of imported food was used

in their production. Of the butter and cheese consumed only about one-third was home produce. About half the margarine was imported.

Dairy produce varies greatly in cost. At pre-war prices, a penny would buy 270 calories in milk, 75 calories in cream, 300 calories in butter, 200 calories in cheese, and 500 calories in margarine.

Sugar.

Sugar, too, was an important item, but the figure given refers to sugar in all forms and includes, not only that used in the household, but all the sugar used in jam factories and in the confectionery trade. It must not be imagined that sugar is eaten merely because of its pleasant taste. Sugar is a valuable food. When eaten it is absorbed more quickly than any other food, and reaches the muscles almost immediately. This makes it especially acceptable to strenuous workers, because it restores their tired muscles and rapidly removes the sense of fatigue. At pre-war prices, sugar gave about 800 calories for a penny, and was undoubtedly a very cheap source of work-producing power. Practically the whole of the sugar consumed in the United Kingdom is imported.

Potatoes.

Potatoes form a smaller proportion of the national food supply than most people think. Including an estimate of the potatoes consumed by those who grow them, they account for only one-tenth of the work-producing power of the nation. Nor are they remarkably cheap. At pre-war prices of a half-penny per lb., a penny only bought about 700 calories.

Other Foods.

All the other items together contribute only about 10 per cent. of the work-producing power of the nation. Looked at from this point of view, their importance is relatively small. They play a part, however, in maintaining the health of the people, and their value therefore cannot be properly stated in terms of their work-producing power.

Everybody has probably heard of the class of substances known as vitamines, but it is doubtful if many people have a clear idea of the importance of these substances. So far as is known at present, there are three kinds of vitamines.

1. Growth Vitamines, which appear to be present in most kinds of food in their natural condition. Our knowledge of these substances is based upon inferences drawn from such facts as the following. Young rats can be kept alive for long periods on a diet composed of a mixture of purified casein (the protein of milk), purified butter fat, purified starch and a suitable proportion of mineral matter. But although this diet will maintain life, it is incapable of producing growth. While they are fed on it, young rats cease to grow, but they begin to grow again as soon as almost any kind of fresh animal or vegetable food is added to their diet.

Again, it has been shown that the rate of growth of young animals depends to a great extent on the presence in their diet of a proportion of fresh animal or vegetable food, which has undergone manufacture and cooking to the least possible degree. These results are best explained by the assumption that most fresh animal and vegetable foods contain substances which may be called vitamines, whose presence in the diet of young animals is essential for growth, and the further assumption that these growth vitamines are destroyed by such treatment as prolonged cooking or by manufacturing processes.

2. Anti-scorbutic Vitamines. It has long been known that sailors, explorers, and other people who have been compelled to live for long periods on dried or otherwise preserved food are apt to develop the disease known as Scurvy. This fact is now explained by the assumption that scurvy is caused by the absence from the diet of substances which may be called anti-scorbutic vitamines, and that these vitamines are destroyed by any of the processes commonly used for preserving foods, and especially by processes which involve drying.

3. Anti-neuritic Vitamines. The disease, known as beri-beri or polyneuritis, has been shown to be due to the absence, from such foods as polished rice, of substances which may be called anti-neuritic vitamines.

There is sufficient evidence of the kind quoted above to show that for the due preservation of growth and health it is desirable that the population generally should be able to obtain a reasonably cheap and plentiful supply of various articles of food which are suitable for consumption with only a minimum of manufacture, cooking or other preparation. Such articles are fruit, salads, and fresh vegetables. For this reason, these articles, although they contribute in only a minor degree to the work-producing power of the nation, probably play an important part in maintaining the national health. In view of these facts, it is important that an adequate supply of fresh fruit, salads, and vegetables should not be overlooked.

II

THE NATIONAL FOOD SUPPLY IN TIME OF WAR

We have now discussed the food supply of the nation in normal times. The essential consideration at the present time, however, is the modification of the food supply, rendered necessary by war conditions. In framing the national food policy to meet the present crisis, the first consideration is the question of waste.

The normal margin. Waste.

Information on this subject can be derived from the Royal Society Food Committee's report already quoted. From this report it appears that the national food supply for the five years before the war provided about 4,000 calories per man. In the same report, it is stated authoritatively that an average man doing an average day's work requires 3,400 calories. From these two figures, it is easy to calculate that the margin of waste was about 15 per cent.,—a not excessive margin for loss in

distribution. From an estimate of the national food supply in 1916, in which the increased population and the increased food requirements of the army are taken into account, it appears that even this comparatively small margin has been somewhat decreased. It may be concluded, therefore, that any decrease in consumption above 5 to 10 per cent. can only be secured by reducing the consumption of food below the standard adopted by the Royal Society Committee as necessary for an average man doing an average day's work. If the consumption is reduced below this level, it must result in a decrease in the output of munitions, farm produce, and other necessary commodities.

Before leaving this subject it is necessary, however, to qualify the above general statement. In the first place, the general statement that decrease in consumption is undesirable, refers to those sections of the population who are engaged in productive work, and it should be remarked that those sections include a far greater proportion of the population now than at any previous period in the history of the nation. There may still be a small number of individuals not engaged in active work, who can reduce their consumption to some extent without impairing their health. A few, indeed, can do so with actual benefit to themselves; but their total number is so small as not to affect the general statement.

Secondly, the history of food prices and food consumption, as recorded in a large number of dietary studies made in different parts of the country at different periods, shows that invariably, whenever prices of food have been high, the consumption of bread by the working classes has increased. The reason for this is obvious, when it is pointed out that even at present prices a penny buys 400 calories in the form of bread, which is far more than the same sum buys in any other form.

As food prices increase, therefore, and the housewife finds it more difficult to make her money buy enough food for her family, she is forced to increase her purchases of bread to the exclusion of dearer articles. It follows from this that in such times as the present, the demand for bread is likely to increase rather than to decrease.

A war food policy should certainly include a campaign

against waste, but it must be recognised that such a campaign can only result in a saving of 5 or 10 per cent. If it exceeds this limit, it can only do so by reducing consumption below the level required for national efficiency.

The war food policy must, therefore, embrace more than an anti-waste campaign. Its main effort should be directed to extending the bread supply, because, as pointed out above, bread is not only the cheapest form of food, but is also, in normal times, the largest item in the national food budget, especially of those classes of the population who are engaged in productive work.

Increase of Bread Supply.

The main problem then of the war food policy should be to extend the bread supply. Let us see how this problem should be confronted. Two obvious methods present themselves at once,—to import a greater quantity of wheat, and to grow a greater area of wheat at home.

Unfortunately, neither of these solutions is easily attained. It is practically impossible to import more wheat than in normal times, or even to import as much, because, in the first place, a large proportion of the shipping is required for war purposes, secondly, the total quantity of shipping has been reduced by the enemy submarine campaign, thirdly, the world's supply of wheat at the present time is below the average, and, finally, before wheat can be imported in war time, it must be paid for.

To grow an increased area of wheat at home, is a problem presenting many difficulties and involving considerable delay. The Government are now taking steps which it is hoped may result in a considerable increase of wheat at the harvest of 1918, provided farmers can overcome the difficulties caused by lack of labour. It does not seem likely, therefore, that these two suggestions will produce any very considerable immediate result.

There is, however, another suggestion which, if it had been adopted earlier, would have certainly saved the situation, and which may still do so if it is put in practice with sufficient energy and determination.

To understand this suggestion, it must be realised that all

kinds of corn, whether home grown or imported, are commonly used for various purposes. A certain proportion is required for seed, in order to grow next year's crop; very large quantities are consumed by the livestock of the country; quite appreciable quantities are also used for various industrial purposes, which do not have the provision of food as their object. The remainder is used for human food. There seems to be no reason against the diversion of very large quantities of home grown and imported corn from animals and industry to human consumption.

Distribution of Grain Supplies.

Table IV gives in round figures the average quantities for the five years before the war (1909–1913) of the various kinds of corn grown in the United Kingdom as well as the quantities imported; also, the proportions of these materials used for seed, fodder, brewing and distilling, industrial purposes, and human food.

The figures show that the average production of home-grown corn amounts to about 6½ million tons. The quantity imported was nearly 10½ million tons, so that the total amount of corn available in the United Kingdom before the war averaged nearly 17 million tons. Of this gigantic quantity, it is estimated that only about 500,000 tons were used for seed; animals consumed about 9¼ million tons, brewing and distilling 1¾ million tons, less brewers' and maltsters' offals, other industries 300,000 tons, leaving for human food rather more than 5 million tons.

It should be noted here that about half the work-producing power of the million tons used for brewing becomes available for human consumption in the beer and in the milk and bacon produced from the consumption of brewers' offals, by cows and pigs.

About ¾ million tons of maize, barley, and rice are used for preparing distilled alcohol, some of which is consumed by human beings in the form of spirits, the rest being used for industrial purposes in the form of methylated or rectified spirit.

Table IV. Origin and Distribution of Grain 1909–13.

Weight in tons

	Origin		Total	Quantities used for				
	Home grown	Imported		Seed	Fodder	Brewing and distilling	Other industries	Human food
Wheat, including flour ...	1,584,000	5,671,000	7,255,000	130,000	2,500,000*	—	125,000	4,500,000
Barley	1,522,000	1,061,000	2,583,000	120,000	978,000	1,435,000	—	50,000
Oats	3,004,000	899,000	3,903,000	200,000	3,503,000	—	—	200,000
Maize	—	2,068,000	2,068,000	2,000	1,683,000	233,000	100,000	50,000
Rice	—	303,000	303,000	—	52,000	70,000	41,000	140,000
Rye and buckwheat ...	50,000	44,000	94,000	10,000	84,000	—	—	—
Sago, tapioca, prepared "cereals"	—	135,000	135,000	—	—	—	35,000	100,000
Beans, peas and lentils ...	370,000	184,000	554,000	25,000	413,000	—	—	116,000
Totals	6,530,000	10,365,000	16,895,000	487,000	9,213,000	1,738,000	301,000	5,156,000

* Under this head are included millers' offals used for fodder.

Distilling is a much more wasteful process than brewing. Spirits contain nothing of food value except alcohol, while beer contains an appreciable amount of nutritive solids in addition to alcohol.

Some of the other materials used for industrial purposes also become available for human food. A considerable quantity of the maize, rice, sago, and tapioca, included under this heading is used for making glucose, which is consumed by human beings in the form of beer, jam, and confectionery.

The Food Controller has already curtailed the use of grain for purposes other than human food. Brewing has been reduced to about one-third of the pre-war figure. The use of wheat and other grains for starch making has been restricted, and the manufacture of alcohol has been limited to the minimum amount required for the manufacture of munitions. These orders have transferred considerable amounts of grain from these purposes to human food. It is, of course, impossible to reduce the amount of grain required for seed; indeed this quantity is likely to be very considerably increased by the efforts which are being made to increase the production of home grown cereals.

By far the greatest part, however, of the 17 million tons of grain, annually available before the war, was consumed by animals. Diversion of grain from industry to human food may help the situation slightly. It is possible, however, that very large quantities of grain might be diverted from animals to human food,—quantities so large as to make the situation secure.

Animal fodder.

Before this can be done, however, some enquiry into the national fodder supply is desirable. Besides the 9¼ million tons of grain or grain products consumed by animals, the livestock of the country before the war consumed also about 1¼ million tons of oil cakes, and practically the whole of the grass, hay, and straw produced in the country.

In Table V an attempt is made to set out figures showing the annual consumption by animals of all kinds of fodder for

Table V.
Consumption of Fodder by Livestock, United Kingdom, 1909–13.

	Thousands of tons	
	Gross weight	Dry weight
Productive fodders		
Concentrated:		
Wheat offals and tail wheat	2,500	2,200
Maize	1,700	1,500
Oilseed cakes and meals	1,200	1,100
Oats	3,500	3,000
Barley	980	840
Beans, peas, rye and buckwheat	500	450
Brewers' and distillers' grains (dried) and malt culms	450	400
Rice meal and offals	250	230
Treacle, molasses foods (say)	100	60
Industrial refuse materials (say)	100	90
	11,280	9,870
Roots:		
Turnips	27,000	3,000
Mangels	10,000	1,200
Cabbages, etc.	3,000	450
Potatoes	1,000	200
Other crops	3,500	350
	44,500	5,200
Grass and hay:		
¼ total produce of good grass land, reckoned as hay	15,000	13,000
Total productive fodder	70,780	28,070
Maintenance fodders		
Grass:		
¾ total produce of poor grass land, reckoned as hay	45,000	38,000
Straw:		
Oat straw	4,000	3,500
Barley straw	700	600
Bean, pea, rye, etc. straw	700	600
Total maintenance fodder	50,400	42,700
Total fodder consumption	121,180	70,770

the period immediately before the war. The Table was first published in a paper communicated to the Farmers' Club on April 23rd, 1917. It has been amended in the light of the discussion which took place at the Club and in view of subsequent investigations. The writer believes that, in its present form, it gives a fair estimate of the annual consumption of all kinds of fodder by livestock, during the period 1909–13.

Table V shows the enormous quantity of fodder consumed by the livestock of the country, amounting to 71 million tons reckoned as dry food.

From the Royal Society Committee's Report, already referred to, it appears that the livestock of the country, including in this term not only cattle, sheep and pigs, but poultry, game, rabbits, etc., produces about 6½ million tons of food containing about 1½ million tons of dry human food. Subtracting from the total fodder consumed by livestock 11 million tons of dry food as the share consumed by the 3 million horses in the country, we may conclude that the rest of the livestock consume 60 million tons of dry fodder to produce 1½ million tons of dry human food, or 40 tons of dry fodder for the production of every ton of dry human food. This should be slightly reduced to allow for pedigree animals exported and for dogs and cats, which consume food but add nothing to the food supply. This correction, however, would not appreciably affect the ratio of 40 of fodder to 1 of human food, both reckoned dry,—a figure which is sufficiently striking as evidence of the great wastefulness of the methods of producing human food by the agency of animals.

These considerations suggest at once that considerable economy could be effected by reducing the number of livestock, or by changing the methods of feeding them, or in both ways so as to set free for human food much of the fodder, which animals have been accustomed to consume. Looking down the list of fodders in Table V, maize, oats, barley, beans, peas, rye, buckwheat, and potatoes, stand out at once as suitable in varying degree for human consumption, and turnips might also be more widely used in case of necessity.

Diversion of food from animals to man.

These articles contain 6½ million tons, or if turnips are included, 9½ million tons of dry food. The very size of this figure suggests that the first point of investigation in working out a war food policy is the extent to which it might be possible to divert from livestock foodstuffs suitable for direct human consumption. That there would be economy in doing so is beyond question, for the grain and potatoes consumed by livestock would supply 6½ million tons of dry food if eaten by human beings directly, whilst if converted into human food indirectly by animals they would not be likely to yield more than, say, half a million tons of dry human food.

To what extent then is it possible to withdraw, from livestock, foodstuffs suitable for human consumption?

Maize.

The first article in the list is maize, of which livestock, before the war, consumed annually about 1¾ million tons. Maize is used to a certain extent for feeding horses, cattle and poultry, but its main use is for pig feeding. Probably 250,000 tons would satisfy the necessary demands of horses and poultry. This would leave 1½ million tons which is at present chiefly consumed by pigs. Used in the most careful manner and supplemented by separated milk, buttermilk, or whey, this quantity of maize would not produce more than 300,000 tons of pork, containing 150,000 tons of dry human food, or one-eighth of the dry human food contained in the maize consumed. In view of these facts, there should be no hesitation in deciding to divert 1½ million tons of maize from pigs to human beings. It would save a million tons of freight if the finished product, bacon and ham, were imported in place of the raw material, maize.

Oats.

With regard to the next item, oats, the conditions are somewhat different. Oats are for the most part consumed by horses, and for horses engaged in productive work they are a necessary food. If the working horses were deprived of their

oats, it would be impossible to maintain agricultural and industrial production. To take all the oats from the horses would necessitate replacing them with an equivalent amount of some other cereal food now available for human consumption. This would result in considerable disturbance and in no corresponding gain.

There are at the present time in the United Kingdom about 3 million horses of which, say, 2 million are employed in necessary work. These horses vary in size and rate of working and it is somewhat difficult to assess their average requirements, but it is not likely that they could be maintained in work on less than 1½ tons per head per annum. This works out at 3 million tons of oats for the working horses, and if, as is right in such times, none are allowed for idle horses, or horses used for pleasure only, half-a-million tons of oats would be set free for human consumption.

Barley, Beans, etc.

Barley is largely ground for pigs, and the same considerations apply as in the case of maize. It is necessary, therefore, to take for human consumption all the barley which is good enough to be milled, say ¾ million tons.

Beans, peas, rye and buckwheat are consumed by livestock to the extent of about ½ million tons. There should be no difficulty in diverting, say, 200,000 tons of these grains to human consumption.

Wheat.

Table IV shows that livestock consumed before the war about 2½ million tons of wheat. This quantity is the sum of the tail and damaged corn, estimated at about one-tenth of the home-grown crop, and the offals of all the home and foreign wheat milled. The recent milling orders have decreased this amount by raising the proportion of flour, which every miller must extract from the wheat he grinds, from about 70 per cent. to 81 per cent. This action should decrease the wheat offals by rather more than half a million tons, which would be transferred to the human food supply.

Summary.

Summarising the above, it appears possible to transfer from animal fodder to human food the following amounts of cereals:

	tons
Maize	1,500,000
Oats	500,000
Barley	750,000
Beans, peas, etc.	200,000
Wheat flour from closer milling	600,000
Total	3,550,000

This quantity would contain 3 million tons of dry human food. If fed to pigs it would produce about 250,000 tons of dry human food, and this is a maximum figure, for the pig is the most economical converter of grain into flesh.

This transference would, therefore, result in a net gain of $2\frac{3}{4}$ million tons of dry human food. These figures are enough to show that the diversion of grain from livestock to direct human consumption is a most important factor in maintaining the supply of human food for the nation.

Brewing and Distilling.

To turn now to brewing and distilling. Table IV shows that these industries use $1\frac{3}{4}$ million tons of grain. Distilling is now practically confined to the manufacture of alcohol and other materials required in the manufacture of munitions. For this purpose it may be assumed that the maize and rice formerly used are still required.

Brewing before the war used 1,435,000 tons of barley in the preparation of 35 million barrels of beer. The $13\frac{1}{3}$ million barrels now permitted would require on the same scale about 400,000 tons of barley. Allowing as usual for seed and for barley not fit for human consumption, there would still be about 340,000 tons of barley left for human food, even if no barley were imported.

Restriction of the use of cereals for industrial purposes might save 200,000 tons for human consumption.

Restricted Imports.

One important point has still to be considered, namely the restriction of imports caused by the destruction of shipping and the claims of the war on the ships that remain. For obvious reasons the publication of import figures has been discontinued, but in various ways it is possible to make a rough guess at the amounts of some of the more important cereals which still reach the ports of the United Kingdom.

For the present purpose it will suffice to guess the present rate of annual importation of corn other than wheat at between $2\frac{3}{4}$ and 3 million tons.

Estimate of cereals, other than wheat, available for 1917–18.

Assuming that the approaching harvest will yield average crops of wheat and barley, and an increased crop of oats because of the increased area sown, and allowing extra seed for the extension in corn growing which it is hoped to realize, the above information may now be tabulated. This has been done in Table VI.

Even with the greatly decreased importation assumed the diversion of grain from livestock and brewing and industry suggested in Table VI provides $3\frac{1}{4}$ million tons of grain, exclusive of wheat, for human consumption. This grain if milled would yield flour and offals as follows:

	Tons grain	Tons flour	Tons offals
Barley	1,130,000	680,000	450,000
Oats	600,000	360,000	240,000
Maize	968,000	800,000	168,000
Rice	150,000	150,000	—
Rye, etc.	20,000	15,000	5,000
Sago, etc.	90,000	90,000	—
Beans, etc.	300,000	200,000	100,000
Totals	3,258,000	2,295,000	963,000

In addition to this $2\frac{1}{4}$ million tons of flour which could be produced from imported cereals on the present reduced scale, there should also be available, after deducting damaged and

Table VI.

Origin and Distribution of Cereals, excluding Wheat, 1917–18.

Weight in tons

	Origin		Total	Quantities used for				
	Home grown	Imported		Seed	Fodder*	Brewing and distilling	Other industries	Human food
Barley	1,500,000	400,000	1,900,000	120,000	250,000	400,000	—	1,130,000
Oats	3,500,000	400,000	3,900,000	300,000	3,000,000	—	—	600,000
Maize	—	1,500,000	1,500,000	2,000	250,000	230,000	50,000	968,000
Rice	—	250,000	250,000	—	10,000	70,000	20,000	150,000
Rye and buckwheat ...	50,000	40,000	90,000	20,000	50,000	—	—	20,000
Sago, tapioca, etc. ...	—	100,000	100,000	—	—	—	10,000	90,000
Beans, peas and lentils...	370,000	100,000	470,000	30,000	140,000	—	—	300,000
Totals	5,420,000	2,790,000	8,210,000	472,000	3,700,000	700,000	80,000	3,258,000

* Under this head are included millers' and brewers' offals used for fodder.

tail corn and an increased allowance for seed for the increased area to be sown, about a million tons of home-grown wheat from the present approaching harvest. This would yield, on the present milling standard, 800,000 tons of flour and 200,000 tons of offals.

Adding these items to the figures shown above, the available breadstuffs would be 3,095,000 tons of flour and 1,163,000 tons of offals.

Estimate of Food Requirements for 1917–18.

It now becomes necessary to estimate how much flour is required for the coming year. It is not possible to base this estimate on pre-war consumption because so many more individuals are now engaged in manual work and consequently require more food. Table VII is a rough attempt to classify the population according to age, sex, and occupation.

TABLE VII.

CLASSIFICATION OF THE POPULATION IN TERMS OF FOOD REQUIREMENTS.

Class	Description	Man value	Number. Millions	Total Man value. Millions
I.	Men doing heavy work ...	1·33	3½	4·65
II.	Men doing average work Boys—growing—age 13–18 Women doing heavy work	1·00	8	8·00
III.	Men doing sedentary work Women doing average work Girls—growing—age 13–18	·80	11½	9·20
IV.	Women doing sedentary work or unoccupied Children, age 10–13	·67	10½	7·00
V.	Children, age 6–10	·50	3¾	1·85
VI.	Children, age 0–6	·40	5¾	2·30
	Totals		43·0	33·00

Average man value of population per 100=77.

Table VII shows that, with the assumed population classed as indicated, the food requirements of the total number of civilians is equal to that of 33 million average men. For the sake of the present argument, it may be assumed that the food requirement of the soldiers and sailors in the country is equivalent to that of 3 million men. The total civilian and military requirements, then, are equal to that of 36 million average men. The Royal Society Committee estimated that the food consumption per average man during the 5 years before the war was equal to 4,000 calories per head per day, a figure which allowed a margin of 15 per cent. for loss in distribution and other contingencies. Of this 4,000 calories, cereals contributed 34 per cent. In view of the shortage of various other items of food in the past, and the possibility of a recurrence, it is necessary in calculating for the future to increase this proportion to 40 per cent., or two-fifths. Two-fifths of 4,000 calories is 1,600 calories. In estimating the cereal requirements, therefore, the estimate should be based on the figure of 1,600 calories per average man per day. The work-producing power of 1 lb. of flour is 1,650 calories, and the error will be slightly on the safe side, if 1 lb. of flour per average man per day is taken as the basis of the calculation.

The requirement of cereals for the whole year will, therefore, be 36,000,000 × 365 lbs. of flour, or almost exactly 6,000,000 tons. Under present conditions this flour will result from the extraction of 81 per cent. of flour from the wheat milled, and although the evidence is somewhat conflicting, 81 per cent. flour is almost certainly less digestible than the 70 per cent. flour commonly used before the war. To allow for this decreased digestibility and other contingencies which may arise, it will be advisable to raise the estimate of flour required for the coming year to 6½ million tons.

It was shown above that home-grown corn together with the diminished imports of grain other than wheat could supply 3,095,000 tons of flour. It is necessary, therefore, to import enough wheat to yield 3½ million tons of flour, in order to make up the total requirement of 6½ million tons. This amount would be 4,300,000 tons of wheat, which would yield 3½ million

tons of flour and 900,000 tons of offals. The total amount of flour thus provided would be 6,595,000 tons, and of offals 2,063,000 tons. On this scheme the total importation of grain would be 7¼ million tons, a reduction of 3 million tons below the pre-war figure.

Estimate of available Fodder for 1917–18.

The question naturally arises: Can the livestock of the country be maintained in a state of efficiency in face of the reductions of fodder suggested above?

Table VIII has been compiled by collecting together the various items above mentioned and by assuming that the fodder crops of the country will, on the whole, yield an average crop this year. So far there is no reason to think that this will not be the case.

On this assumption, roots, grain, hay and straw will reach the same average figure as before the war, but concentrated foods will be reduced from 11,280,000 tons to 6,880,000 tons, a reduction of 40 per cent. on the pre-war figure. What effect will this reduction have on the live stock of the country?

In order to facilitate the examination of this problem, the table is arranged so as to divide the total fodder supply into two classes, maintenance fodders and productive fodders.

The purpose of this classification needs a word of explanation. When fodder is eaten by an animal, it must be chewed, swallowed and digested before the animal can be nourished by it. Now, chewing and swallowing involve muscular work, and digestion involves chemical work as well. Part of the nutrients of the fodder are used up in providing the energy for these processes, and are converted into heat which is, or may be, useful to the animal for keeping its body warm.

It is obvious that a coarse fodder like straw, or rough grass, or hay, will require much more chewing and digestion than concentrated foods like grain or oil cakes, more too than soft succulent foods like roots, and than good quality grass or hay.

A fodder, then, has two values: the gross value and the net value, i.e., the value after deducting the proportion used in chewing and digesting. For coarse fodders these values are

Table VIII.

Estimate of Fodder available for Livestock. United Kingdom, 1917–18.

	Thousands of tons	
	Gross weight	Dry weight
Productive fodders		
Concentrated:		
Wheat offals and tail wheat	2,000	1,700
Maize	250	220
Oilseed cakes and meals	600	550
Oats	3,000	2,600
Barley	250	220
Beans, peas, rye and buckwheat	190	160
Brewers' and distillers' grains (dried) and malt culms	160	140
Rice meal and offals	10	9
Treacle, molasses foods, say	10	9
Industrial refuse materials, say	10	9
	6,480	5,617
Roots:		
Turnips	27,000	3,000
Mangels	10,000	1,200
Cabbages, etc.	3,000	450
Potatoes	1,000	200
Other crops	3,500	350
	44,500	5,200
Grass and hay:		
¼ total produce of good grass land, reckoned as hay	15,000	13,000
Total productive fodder	65,980	23,817
Maintenance fodders		
Grass:		
¾ total produce of poor grass land, reckoned as hay	45,000	38,000
Straw:		
Oat straw	4,000	3,500
Barley straw	700	600
Bean, pea, rye, etc. straw	700	600
Total maintenance fodder	50,400	42,700
Total fodder available	116,380	66,517

very different, for the work of digesting them is large. For better class fodders the two values are almost the same, for the work of digesting them is small.

Now, the first call upon the food an animal eats is for the maintenance of the body temperature and of its vital functions such as digestion, breathing, heart beat, etc. For this purpose, coarse fodder is quite satisfactory because the work done in digesting it is converted into heat, which serves a useful purpose in keeping the body warm.

But when the diet reaches the maintenance standard, any further formation of heat is wasteful and serves no useful purpose,—in fact, the animal is compelled to get rid of it and may even be embarrassed somewhat in doing so. For this reason, it is wasteful to give an animal much more coarse fodder than it requires for maintenance, for by doing so a large proportion of the extra food which must be converted into heat in the process of digestion is lost, and there is no effective balance left for producing growth, meat, milk or work.

Maintenance Fodders and Productive Fodders.

Consequently, coarse fodder can be used to keep animals alive, or as it is usually said, for maintenance, but is not of much use for production of growth, meat, milk or work. For production, concentrated foods, roots, or good quality grass or hay are required.

The total fodder supply is therefore classified as fodders suitable for maintenance, and fodders suitable for production.

At the present time, with an average season, the supply of maintenance fodders should be about the same as it was before the war. But the supply of productive fodders has decreased from 28 million tons, reckoned as dry food, to 24 million tons, a decrease of 15 per cent. or between one-sixth and one-seventh. The maintenance fodder supply is not likely to decrease by more than the ordinary seasonal fluctuation. Broadly speaking, therefore, it will be possible to maintain our livestock, but it will not be possible to produce so large a total output of growth, meat, milk and work.

The next step is to enquire how to regulate the reduction in

the sum of these products. In the first place, the reduction in the output of work cannot be unlimited. Both agriculture and industry would suffer if productive fodder were withheld from working horses. It is, therefore, necessary to allot a minimum, estimated at 3 million tons of concentrated foods, chiefly oats, for horses employed in productive work. Idle horses and horses used for pleasure should get no productive food. They can be maintained on coarse fodder which is likely to be fairly plentiful.

It is also necessary to keep up the supply of milk, because milk is indispensable for infants and invalids, and because a given quantity of fodder yields more animal human food in the form of milk than in any other way. To keep the supply of milk up to the normal, it is estimated that at least 1 million tons of concentrated food, chiefly oil cakes and wheat offals, must be allotted to the milking cows.

These two items, working horses and milking cows, will require at least 4 million tons of concentrated food, and they should be given priority over other kinds of livestock.

Estimate of Productive Fodder available for 1917–18.

As the total amount of concentrated food likely to be available for live stock in the year 1917–18 is only 6,880,000 tons, and the horses and milking cows will require at least 4 million tons, there will remain to be divided amongst the cattle, sheep, pigs, and poultry rather less than 3 million tons. Before the war these classes of livestock used to consume at least 6 million tons of concentrated food. The amount available is likely to be only about one-half of this quantity. With so great a reduction, the ordinary system of producing beef, mutton, pork and poultry must evidently be revised, and some consideration is necessary before the method of revision can be chosen most advantageously.

Animals as Food Producers. Relative economy of Conversion.

All classes of livestock have as their primary purpose the conversion of fodder into human food, and they vary in the economy with which this conversion is effected.

Thus an average cow during her life is estimated to consume about 27 tons of fodder reckoned as dry and to produce in the form of milk, veal from her calves, and beef from her own carcase, about 2¼ tons of dry human food. Her consumption thus works out at 12 lbs. of dry fodder for 1 lb. of dry human food.

A pig will consume 7 lbs. of barley (6 lb. dry weight) in the production of 1 lb. of pork containing half its weight of water. From this it can be calculated that 12 lbs. of dry grain are required to produce 1 lb. of dry human food in the form of pork. It should be noted that the pig, as usually fed in Great Britain, feeds almost exclusively on grain, potatoes and other foods which are now required for human consumption.

An average pullet in the first 18 months of her life consumes about 100 lbs. of corn and meal or their equivalent, lays about 180 eggs and, when killed, weighs about 4½ lbs. From these figures it appears that she consumes about 14 lbs. of dry fodder to produce 1 lb. of dry human food.

The sheep is a rather more economical converter of fodder into food. A sheep ready for slaughter at about 12 months old will have eaten about 6 cwt. of fodder reckoned as dry, and will yield about 28 lbs. of dry human food. At the same time, the sheep will have produced, say, 10 lbs. of wool. If this is taken into account the sheep is not a very wasteful producer.

A three year old steer, by the time he is prime fat, has eaten since birth about 8 tons of fodder, reckoned as dry. Such a steer when killed will yield about 800 lbs. of beef, containing about 2½ cwt. of dry human food. From these figures it appears that a steer consumes about 64 lbs. of dry fodder in producing 1 lb. of dry human food.

These instructive results are collected in Table IX.

It should be noted that in estimating the above figures no allowance has been made for the fodder consumed by the parent animals kept for breeding, except in the case of the cow, where the male parent only was not allowed for.

In drawing conclusions from this Table for application to the present state of affairs, it is necessary to pay regard to both of the last two columns.

The cow is evidently an economical converter at any time, and is specially valuable now because she converts a diet which consists chiefly of grass, hay, and roots, which are not suitable for human food, into milk which is indispensable for infants and invalids. Every effort, therefore, must be made to keep up the number of milking cows.

TABLE IX.

RELATIVE ECONOMY OF DIFFERENT ANIMALS AS FOOD PRODUCERS.

Name of animal	Kind of human food produced	Lbs. dry food consumed per lb. dry human food produced	Kind of fodder consumed
Cow	Milk, veal and beef ...	12	Chiefly grass, roots and hay
Pig	Pork, bacon, ham, etc.	12	Chiefly meal made from grain
Fowl	Eggs and flesh ...	14	Chiefly grain
Sheep	Mutton (and wool) ...	24	Chiefly grass, roots and hay
Steer	Beef	64	Chiefly grass, roots, hay and straw

The pig, whilst as good a converter as the cow, unfortunately feeds largely on meal made from grain which at the present time is required for human food. There is no merit nowadays in converting 12 lbs. of grain, reckoned dry, into 1 lb. of dry human food in the form of pork. Indeed, to do so is to waste human food. Grain feeding for pigs must, therefore, be greatly reduced, or completely stopped in the case of grain fit for human consumption. Methods of pig feeding must be revised so as to achieve this result. Pigs must be fed in the winter chiefly on roots, in the summer on grass or other green foods, and meal in the form of the finer wheat offals used only for weaning and finishing. The finishing must cease at a much earlier stage of fatness than has been customary.

Poultry also fall under the same ban as pigs. They are fairly economical converters, but unfortunately they feed chiefly on grain, which cannot be spared at the present time. It is not to the national interest to convert 14 lbs. of dry grain into 1 lb. of dry human food in the form of chickens and eggs. It is, however, desirable that anything unsuitable for human consumption should be so converted, and everyone should keep fowls or pigs who has household or garden refuse and can buy millers' offals, damaged corn or other similar materials.

Sheep are fairly economical food producers. Taking into consideration the facts that they produce wool as well as food and that their diet consists chiefly of grass, hay and roots, they may certainly be encouraged.

Beef production, however, as normally carried on, is a most wasteful process about which there is much misapprehension among farmers, dealers and butchers. When it is realised that 64 lbs. of dry fodder are consumed in producing 1 lb. of dry human food in the form of beef, it becomes obvious that enquiry is needed.

Wastefulness of Beef Production.

The first point to which the enquiry should be directed is to find out why the three year old steer should have consumed more than twice as much dry fodder in making a pound of dry human food as is consumed by any other class of food-producing animal. The reason of this is not far to seek. Pigs are usually slaughtered before they are a year old; with sheep the age of slaughtering is probably a little more than this, but not very much. Steers are commonly slaughtered between the ages of thirty months and three years. It has already been pointed out that, as long as an animal remains alive, it requires considerable amounts of fodder to maintain its vital functions. A three year old steer by the time it is ready for the butcher will have consumed 8 tons of dry fodder, which works out at an average of 17 lbs. per day through its whole life. Rather more than half of this,—say, an average of 10 lbs. per head per day, or 5 tons in the aggregate—will have been used up in maintaining the vital functions of the animal. It follows from this

that the longer an animal is kept before it is finally prepared for the butcher, the more fodder it wastes on maintenance.

This is undoubtedly the chief reason why the three year old steer is such a wasteful converter of human food. The only reason why it is economically possible for a farmer to make human food through the agency of so wasteful a machine, is that much of the fodder consumed is the produce of poor grass land, which is extremely cheap and calls for very little labour.

The remedy for this state of things is the extension of the use of early maturing breeds for the production of baby beef. If, for instance, a steer can be brought to the butcher at eighteen months instead of three years, at least 3 tons of maintenance fodder will be saved, and it is estimated that such a steer would produce a pound of dry human food from the consumption of only about 30 to 35 lbs. of dry fodder. Calves slaughtered for veal, as is the common practice on the Continent, are still more economical from this point of view.

For economy of fodder, therefore, in the production of beef, early maturity is the ultimate ideal, but unfortunately it is an ideal which cannot be immediately attained. Also, the shortage at the present time is confined to productive fodders used for fattening, and there is no reason to anticipate any grave shortage of maintenance fodders.

An immediate economy can, however, be effected in the fattening process, and economy in this direction saves concentrated productive foods, the shortage of which is becoming very acute.

Diminishing Returns in the fattening of Stock.

Table X summarises the results of a long series of investigations on beef production. The first line gives the average weight of all the animals used, amounting to over a hundred, at the beginning of the fattening season, and at the end of each subsequent month.

The second line gives the average weight of carcass which would have been obtained by slaughtering the animals at the end of each month of the fattening period. It was estimated that the stores would yield 52 per cent. of their weight as dressed

carcass. The fat animals at the end of the sixth month were found to yield 58 per cent.

The third line shows the increased weight of carcass produced during each month. It is noteworthy that during the first three months the increase amounted to about 50 pounds of flesh per month. For the fourth month only about half the quantity of increased flesh was produced, and for the fifth and sixth months this amount fell to 19 lbs. and 16 lbs. respectively.

TABLE X.

DIMINISHING RETURNS IN THE FATTENING OF STOCK.

	As stores	End of first month	End of second month	End of third month	End of fourth month	End of fifth month	End of sixth month
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Average weight of animals	1016	1086	1156	1226	1254	1268	1275
Average weight of carcass	528	576	624	674	702	723	740
Weight of flesh produced during month	—	48	48	50	28	21	17
Flesh produced per week	—	12	12	12½	7	5¼	4¼
Dry human food produced per week	—	3½	4	4¼	2½	2¼	2
Dry fodder consumed per week	—	182	196	210	224	224	224
Weight of dry fodder for 1 lb. of dry human food	—	52	49	64	90	100	112
Lbs. of concentrated food consumed per week ...	—	28	42	56	70	70	70
Lbs. of concentrated food used per lb. of human food produced... ...	—	8	10½	13	28	30	35

The amount of dry human food produced, given in the fifth line, is estimated from analyses of meat at various degrees of fatness. These analyses show that in the mixed flesh and fat of a very lean animal the dry food material only amounts to 30 per cent., the remaining 70 per cent. being water, while in the mixed flesh and fat of a prime fat animal, the dry human food amounts to 50 per cent., the other half being water. Even after allowing for this increase in the food value of really prime meat, the quantity of dry human food produced per week in the

last three months of the fattening process only amounts to about half as much as is produced during the first three months of fattening.

The sixth line shows that in spite of this decrease in the rate of production of human food, the amount of dry fodder consumed increased, and as shown in the last line but one, this increase is chiefly due to the increase in concentrated food.

The last line shows that for the first three months from 8 to 13 lbs. of concentrated food are used per lb. of dry human food produced, whilst in the last month as much as 35 lbs. of concentrated food are required to produce 1 lb. of dry human food.

It is very noticeable that in almost every line of the table there is a sharp change between the third and fourth months, which indicates that from the point of view of economy in fodder, and especially of concentrated fodder, the fattening process should be stopped after about three months, at which stage the animal will yield about 54 per cent. of dressed carcass. By adopting this change in procedure, the consumption of concentrated food would be reduced to about half the pre-war figure, and the amount produced would be reduced by not more than 10 per cent.

In view of these facts, the obvious policy for those engaged in beef production is to shorten their fattening period to about three months, and to sell their animals for slaughter when they are estimated to yield about 54 per cent. of dressed carcass.

Complete figures like those above are not available for grass-fed cattle. The few figures which are available, however, indicate that the gain in live weight during the first half of the grazing season is about twice as great as the gain during the second half of the grazing season,—results which are quite in agreement with those embodied in the Table, which refers, of course, to stall-fed cattle. The policy, therefore, for grass-fed cattle should also be to sell them for slaughter half way through the grazing season so as to make room for a second lot of cattle.

With regard to mutton production, the figures which are available show results quite similar to those quoted above for beef. The policy with regard to fattening sheep should therefore be framed on similar lines.

Summary of suggested policy.

The policy outlined above may now be briefly summarised as follows:

Pigs should be fed on roots and green stuff, supplemented with scraps and waste together with a small allowance of millers' offals or meal made from damaged corn for weaning and finishing.

Poultry should be fed on scraps and waste, with damaged corn, wheat offals and other foods not fit for human consumption.

Cattle and sheep should be slaughtered in a much less fat condition than has been customary in the past, and every effort should be made to secure early maturity.

The adoption of this policy will effect great economy in concentrated feeding stuffs, and will, by bringing animals to the butcher more quickly, cause such a reduction in numbers as will equalize the demand for feeding stuffs and the supply. The reduction must, of course, be so regulated as not to deplete the stock of high class animals for breeding.

To ensure this result, it will be necessary for the authorities concerned to keep themselves in close touch with the numbers of animals in the country, and in view of the knowledge thus obtained, to take steps to prevent the slaughter of milking cows, and to increase or decrease as occasion may require the rate of slaughter of other animals. In case the total reduction in livestock brings down the numbers to such a level that the normal meat supply can no longer be maintained, the importation of meat must again be increased. In view of the figures set forth above, it will obviously save tonnage to import ready made meat instead of importing the raw materials from which the meat can be made at home.

Lessons from Germany.

The object of the policy set forth above is to obtain for the feeding of the people the largest possible amount of home-grown and imported food. In order that this object may be successfully achieved it is absolutely necessary that the authorities charged with carrying out the policy should inform them-

selves of the results of the methods which have been used in Germany for carrying out a policy framed on similar lines. The German Government set out at the beginning of the war to secure for human consumption the largest possible amount of home-grown potatoes, cereals, and other farm crops. As in the policy outlined above for this country, the German Government recognised that the livestock of the country was the greatest consumer of agricultural produce. They determined to divert agricultural products suitable for human food from livestock to human beings by ordering increased slaughter of livestock and by taking over from the farmer his potatoes and cereals at a fixed price.

When the German Government decided to carry out this policy it failed to perceive at first two important sequels which must necessarily follow.

In the first place, the distribution of food throughout the country depends for its motive power on the fact that prices are normally higher in the towns where consumption is greatest than in the country where production is greatest. Consequently, the fixed prices paralysed the normal channels of distribution, and the large towns starved, though there was still food on the farms. To prevent this, the State was at once compelled to take over the farmers' crops on their farms. This meant the establishment of a vast organisation for taking over and distributing the crops. The history of this organisation has been summed up by a speaker in the Reichstag. "The first stage," he said, "was for the State to declare that it would take over all crops. The second stage was the setting up of a Committee of Control. The third stage was the appointment by the Committee of a vast army of officials. The fourth and final stage was the disappearance from the market of the commodity in question."

This statement is no doubt an exaggeration for political purposes, but the undoubted fact remains that the system of State distribution in Germany did break down because of its vast complication, and did decrease production by enormously increasing the difficulties and restrictions under which the farmers were compelled to work.

A second point which was not foreseen was that a fixed price for any one commodity at once turns the farmers' efforts towards the production of some other commodity, whose price is left free. This has been ably illustrated by a most distinguished German writer on Economics, who has pointed out that if the farmer hands over his barley to the Government for human food, he only gets for it the fixed price of 2*d.* per lb. Since 7 lbs. of barley will make 1 lb. of pork, and since 1 lb. of pork sells for 2*s.* 4*d.*, if he grinds his barley for feeding his own pigs, it realizes 4*d.* per lb. This is such a strong temptation to the farmer to keep his grain for pig feeding that he has risked all the penalties threatened, and his barley has not been handed over to the State for human food. This is only one illustration of the general principle that the farmer will devote his best energies to the production of that commodity which he believes to be most profitable to himself.

The statements set out above are not merely opinions, but facts which can be readily ascertained by anyone who spends a little time in studying German publications. It is most desirable that all those who are engaged in framing the war food policy of Great Britain should devote some time to the study of these publications, so that the policy they finally adopt should avoid the mistakes which have been in a great measure the cause of the food troubles of Germany.

General principles and their application.

The policy which should be adopted must be based on five general principles.

1. It must secure the maximum amount of food for human consumption.

2. It must be sufficiently simple to be put into actual practice.

3. It must avoid dislocation of the ordinary channels of distribution.

4. It must remove temptation from the farmer, by making agricultural products which can be dispensed with less remunerative than those which are indispensable.

5. It must be enforced by penalties so heavy that no one dare risk them.

It is suggested that these principles can be given effect as follows:

The first step must be the publication of an order forbidding the use of potatoes and cereals for feeding livestock or for any other purpose than for human food, with certain exceptions in the case of samples not fit for human consumption and certain permits under licence for certain classes of animals and industries. There must be no complicated system of grading. In the present emergency there should be only two grades, namely, (grade 1) everything that is fit for human consumption, (grade 2) the remainder.

In order that distribution may be conducted through the ordinary channels, there must be a certain elasticity in price which will allow distributing agents to make sufficient profit to maintain their normal efficiency. This would be most easily achieved by adopting maximum rather than fixed prices. These maximum prices for all agricultural commodities must be fixed in due relation to one another, so as, for instance, to make it unremunerative for the farmer to use sound corn or potatoes for feeding his livestock. For this purpose, a committee of practical, scientific and economic experts should be set up, and charged with the computation of relative prices. This would be a difficult task, but a properly constituted committee should be able to reach satisfactory conclusions. The following calculations are intended to illustrate the general principles of the method that should be followed.

The relative prices of different kinds of grain should first be re-adjusted, so as to remove from the farmer the temptation to use wheat rather than other grains for feeding stock. The commonly accepted measure of the value of a feeding stuff for livestock is the number of food units per ton. The well-known formula for this number is 2·3 (percentage of digestible protein and fat) + (percentage of digestible carbo-hydrate) + (percentage of digestible fibre).

Calculated on this formula, wheat on the average contains 90 food units per ton, barley 83, and oats 75. At the price

of 60*s*. per quarter which was the average for 1916 wheat sold for £14 per ton, or 1½*d*. per lb. Dividing the price per ton by the number of food units per ton, the average cost per food unit of wheat in 1916 was 3*s*. 1½*d*. Taking this figure as a starting point, the value of a ton of barley containing 83 food units would be 83 × 3*s*. 1½*d*. = £12. 19*s*. 4*d*. per ton. This corresponds to 46*s*. 4*d*. per quarter of 400 lbs. or 1·39*d*. per lb.

The corresponding price of oats, containing 75 food units per ton, works out by the same method at £11 14*s*. 4*d*. per ton, or 32*s*. 6*d*. per quarter of 312 lbs.

Taking the average prices for the years 1900 to 1916 as a basis, if wheat is 60*s*. per quarter, barley should be 50*s*. and oats 36*s*. Prices calculated on the food unit basis and on the basis of past average prices do not agree. The latter method is probably the more reliable, as it is based on many years' experience of prices.

The starting point for working out the ratio of grain and meat prices is the generally accepted fact that 7 lbs. of barley are consumed in the production of 1 lb. of pork. At the above prices of barley, 1·39*d*. per lb., the food required to produce 1 lb. of pork would sell for 1·39 × 7 = 9¾*d*. Since the cost of the food is not the sole item of expenditure in the production of pork, it would make pork production less remunerative than barley selling, if the maximum price of pork were fixed at 10*d*. per lb., the price of barley being 46*s*. 4*d*. per qr.

During the last few years the average price of pork has been slightly higher than that of beef. If the prices suggested above for corn and barley are accepted, a maximum price of 10*d*. per lb. for beef would not make beef production sufficiently attractive to the farmer to induce him to feed his corn to his cattle.

Before the war, when the average wholesale price of first quality beef was 55*s*. per cwt. or 6*d*. per lb., the average all-the-year-round contract price for milk delivered in London was 8½*d*. per gallon, including 1*d*. per gallon for railway carriage. With beef at 10*d*. per lb., milk therefore should be delivered in London all the year round at an average contract price of 13½*d*. per gallon, including as before 1*d*. per gallon for railway carriage.

These calculations are suggested as an illustration of the

methods which should be used by the proposed committee. They are intended merely to show that the prices of agricultural commodities are mutually related and that their relationships are susceptible of investigation. Such investigation should be the basis of price fixing.

It would be necessary to enforce the proposed restrictions on the use of grain for feeding stock, and the regulations as to sale, by the announcement of heavy penalties for their infringement, penalties which it would not pay anyone to risk. It would also be necessary to state that the Food Ministry or the Wheat Commission would have the power to requisition agricultural produce and that they would not hesitate to use it in case of undue holding up from the market.

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